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SAVING MONEY IN OFFICE PRACTICES 9

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SAVING MONEY IN OFFICE PRACTICES 9

Saving money in Office Practices

Introduction:

The many small but important energy saving measures that can be carried out in an office add up to a potentially large reduction in energy consumption.

Dealing less with heating, cooling and lighting — which are covered in other booklets in this series — this booklet deals more with the myriad of other "do's and dont's" that make for an energy efficient office environment.

An energy-saving plan for the office

When you think of cutting down energy use in the office, a few obvious (and important) things come to mind — turning off lights, turning down thermostats and turning off electrical equipment when not in use, are the standard ones.

But saving energy and money in office practices goes much further than that.

Think, for example, of all the paper that is used in the office each day. By examining ways to cut down on paper use, a great deal of energy can be saved — energy used to manufacture the paper, energy used to ship it, and for that matter, human energy used to file, read and store it. Money can be saved as well — money used to purchase paper, money paid to people who file it, money spent on filing cabinets to store it, and money needed to rent or buy office space to accommodate the filing cabinets.

Energy and money can also be saved by changing the existing setup at the office. Some companies have cut down working hours to save on heating and lighting; others have reduced use of elevators; and still others have taken down partitions in the office so that air can circulate more freely.

The savings to be gained by a particular office energy conservation program often aren't large, but they are significant and most cost very little — frequently nothing — to implement. They have the added benefit of making office employees aware of energy conservation. In many cases, they also increase the efficiency of office operations.

Take a look around the office to see where energy can be saved. The dollars that can be saved — and the areas in which they can be saved — may surprise you.

The office environment — heating, cooling, ventilating, lighting, water

A major contribution to the present high rate of energy consumption in buildings has been the emergence of engineering technology and equipment which provides sophisticated space environments. Quite naturally, the building occupants have become accustomed to the new environmental standards — bright ambient lighting; heat at a uniform 22°C, summer or winter; 50% humidity; high rates of ventilation. In a manner similar to the auto industry, the trend was to standards that consumed more and more energy. Use of energy per se is not bad for the economy. Without it we would not have been able to enjoy the standard of living we now have. However, the problem is that a large proportion of this energy is being wasted, and it is this energy wastage which must be reduced or eliminated.

Now the trend has been checked, and in some cases reversed. But it will take time to change the habits and minds of the people involved. Energy conservation does not mean discomfort (there is ample evidence to show that a reasonable environment can be achieved at acceptable levels of energy consumption). However, there is a need to keep people informed of reasons for energy conserving measures so that they will greet changes more favourably.

Saving energy through heating — more than turning down thermostats

Turning down the thermostat — to 20°C during the day, and 17°C during the night and on weekends — can save a good deal on an office heating bill. The Office of Energy Conservation estimates that turning the heat down to these temperatures from 22°C saves about 15% on the

Per cent annual fuel saving with 5°F (3°C) night setback

(Based on eight-hour period)

City	Percentages
Halifax	6
Montreal	5
Ottawa	4
Toronto	6
Hamilton	5
Winnipeg	2
Calgary	3
Edmonton	2
Vancouver	7
London	5

average heating bill. By turning the thermostat even lower at night, greater savings can be effected. One study indicates that by setting the thermostat back 5 degrees at night, savings of 19.8% can be effected in Toronto, and 23.5% in Vancouver.

One way to make sure the heat is turned down at night is to install a dual thermostat/timer system. Here, a time circuit is wired up in which a seven-day central timer activates a "night thermostat" each evening and on weekends. There is a manual override at the burner to allow janitorial staff or people working late to leave the thermostat on the "day" setting. Automatic, timed controls, remove much of the "human factor" for the control of energy conservation, and can be counted on to pay for themselves in short order. They also have other applications, among them, lighting, air conditioning, and ventilation.

When the air distribution system is poorly designed, resulting in drafts, it is hard to maintain lower space temperatures. It is sometimes necessary to balance or improve air distribution in order to achieve comfortable conditions at lower temperatures.

Employees aren't always enthusiastic about temperature changes. In fact, when the thermostats are first turned down, workers often feel cold. The best advice here is to explain the situation. Let employees know, for instance, that for every degree above 20°C, 2½% more energy is consumed.

Discourage the use of space heaters since they use large amounts of energy. Suggest that the dress code might be relaxed a bit so that employees can wear sweaters, slacks and other comfortable clothing.

But savings can be increased in other ways. Take a look around the office. Make sure your thermostat is in a good location, away from any drafts or sources of heat which may cause a false reading. If the thermostat is near a heat source, it may be shutting off before the correct temperature is reached. And if a draft is making the area around the thermostat cool, you may be wasting energy by heating to more than the required temperature. If this is the case, consider moving the thermostat.

Drapes — especially lined ones — help insulate windows and stop drafts. Drapes should be closed at night, since both the material and the dead air between the drapes and the window provide insulation. For extra savings, some companies install drapes lined with foil to make greater use of the principle. However, when the winter sun is shining, open the drapes and let solar heat supplement the heating system.

Make sure nothing is blocking sources of heat. If drapes are covering baseboard heaters, shorten them. Make sure office furniture is not blocking heaters, preventing the free flow of air.

Sometimes partitions stand in the way of air flow, and rooms are poorly heated. Consider removing partitions to make sure air can circulate more freely, if partitions are keeping the heat from reaching some areas of the office.

On the other hand, barriers can be used effectively if only some parts of the office are to be heated. Keep the doors to unused rooms and storage areas closed, if those areas don't have to be heated. Zone control is helpful in this respect. If there are thermostats in every room, turn them down in the rooms that don't require heat. Consider installing zone controls if some areas of the office don't have to be heated.

Frequently a little capital outlay can go a long way. One of the best examples of this is spending a little money caulking windows and weatherstripping doors to keep the heat in. It virtually always pays off.

Another way to save energy in heating is to make sure the heating system is in good shape. Most of the energy waste in a furnace or boiler can be attributed to the amount of air being supplied for

combustion and to the condition of the heat transfer surfaces. Too much air reduces the efficiency of the combustion process and wastes fuel; too little air does not permit the complete combustion of the fuel and also leads to higher bills. A scale deposit of 0.012 inches thick inside a boiler tube reduces the rate of heat transfer by as much as 45%. Soot deposits on heat transfer surfaces also reduce the rate of heat transfer and result in fuel waste. Schedule or contract for regular maintenance on furnaces or boilers to ensure efficient operation.

Keeping cool in summer

Air conditioning isn't as much of a concern as heating in our Canadian climate, but there are still more than a few weeks in the summer when keeping cool — either by an air conditioning system, or just keeping out the sun's heat — is a very vital function.

Air conditioning is a big energy user — and the best way to save that energy is to avoid using it if possible. Use fans — preferably ceiling fans — not only are they cheaper, they also use less energy than air conditioning.

Fans do little to reduce humidity, and they don't remove dust or pollen from the air. But the heat waves we experience in Canada are seldom of long duration — something to keep in mind when deciding whether to invest in an air conditioner.

There are other ways to keep cool. Encourage employees to wear light clothing in summer. Don't use appliances — photocopiers, electric typewriters, etc. — unless you have to. They too generate heat. Turn out the lights where possible since they generate heat as well.

Remember that some of the same principles that apply to keeping heat in during winter, apply to keeping heat out in summer. Insulation is one of the best ways to keep heat out. Keep doors and windows closed during the hot part of the day if it's cooler inside. But, if there's a breeze, open the windows since circulating air feels cooler. Keep drapes closed during the day. Light drapes and blinds are especially helpful since they reflect the sun's rays and can reduce solar heat by as much as 50%.

Think about installing awnings, sun screens, panels, overhangs or reflecting window films. The latter can reduce heat gained through windows by as much as 80%. Phoenix Mutual Life Insurance Company in Hartford, Connecticut experimented with reflecting films on windows, and saved about six percent on cooling (see case history). Reflective coatings can be a viable alternative to installation of additional, expensive air conditioning. If your office has storm windows, leave them on in the summer to keep the heat out, providing they can be opened to let breezes in when it is cool outside.

If it is decided that air conditioning is needed, there are still a number of ways to reduce your energy bill. Make sure your air conditioner is the right size for the office, i.e. the one that uses the least electricity for the required amount of cooling. Check the Energy Efficiency Rating (EER) — a measure of the amount of cooling achieved in relation to the amount of electricity used. EER is determined by dividing the Btu per hour rating of an air conditioner by the watts of power it uses. The higher the EER, the more efficient the unit and the less power it will consume. The information needed to calculate the EER can be found on the information plate on the machine. U.S. made air conditioners carry a tag showing the EER, and Canadian models must now carry a CANTAG label showing the EER and the range of EERs on available units of the same cooling capacity.

The temperature setting for the air conditioner should be as high as possible without creating discomfort — 26 to 27°C.

During cool periods in the summer, turn off the air conditioner and open the windows to save energy. But let employees know they should never have windows open while the air conditioning is on. This adds a major load to the system.

Make sure the air conditioner is well-maintained. The three to five percent of the cooling investment required to maintain the system in good working order will return 20% in energy savings, extended equipment life, and critical breakdown repair costs.

In small buildings, it is probably more economical to contract for air conditioning maintenance. Require the contractor to have a scheduled maintenance plan written especially for your building before signing an agreement. And, if you use your own maintenance staff, insist on use of an organized, preventative maintenance program.

The automatic timing devices

Time switches are simple, rugged energy saving devices. The proper type of switch should be selected for optimum results. The specific needs of the installation must be considered in order to gain the timing flexibility required.

Several types are available:

1. **24 Hour Dial**
   This controls the same on-off times daily and would, as an example, be used where security lighting is necessary seven days a week.
2. **Skip-a-Day**
   This 24 hour unit provides the same daily on-off times, but can skip selected days when not required. Suitable for commercial or industrial applications with no occupancy on weekends or holidays.
3. **Seven-Day Dial**
   Provides seven-day control with the flexibility of different on-off times for each day (and the skip-a-day feature for selected days of the week). Used in store interior lighting where daily hours vary.
4. **Photo-electric Sun Switch**
   The Sunset-to-Sunrise dial functions in this fashion. At sunset the lights are turned on and remain on until sunrise or any pre-set hour. Mainly used where security lighting is necessary. This unit is designed to adjust to the daily change in the sun's schedule automatically.

Selecting the right timing device

Care in the selection of the timing device is recommended to assure the flexible control of the interior or exterior lighting system to meet your energy saving needs. Discuss the installation of timing devices with a qualified electrical contractor to assure best results. They save energy, time, manpower and money. Installing the correct timing device for your lighting system will result in savings of energy and future operating costs.

Some tips on air conditioner maintenance:

- Clean dust and dirt off inside and outside coils before the summer starts.
- Be sure the blower and electric motor are lubricated, and follow other manufacturer's recommendations.
- Check the tension on the fan belt in a central forced air system — you should be able to press it down between ¼ and ½ inch. If it does not meet these requirements, change the tension by moving the adjusting screws found on the mounting frame that fastens the motor to the blower housing.
- Check the filters on the unit and clean or replace them where necessary.
- In a central cooling system, the filters should be checked once a month.
- During the winter, either remove window-mounted units or seal the window, or seal the unit on both sides with plastic, wood or

a piece of styrofoam. Tape it up well so that cold air won't infiltrate.

- Install seven day timing devices — similar to the ones used on heating systems — to make sure the air conditioner is not running all night or all weekend.
- If the air conditioning system is a central system with control based on either terminal reheat or dual duct, it may be economical to convert to "variable-air-volume". In most cases, such a step would require a consultant's study.

Ventilation

Excessive ventilation air is one of the biggest energy-wasters in offices. Current codes are ambiguous, but they often require 7.5 to 10 cubic feet per minute per person of outside air — air that has to be heated or cooled, humidified or dehumidified, cleaned, deodorized and moved. All that takes energy.

To cite a parallel, in submarines as little as one cubic foot per minute (cfm) is sufficient. Given that figure, in some buildings a reduction to 5 cfm per person is feasible — representing a 33% to 50% cut in energy use. In one case a 10% reduction saved 1.74 MMBtu/yr per 1,000 cfm of system capacity. In general, good engineering practices should be applied based on local conditions to determine the minimum amount of outside air which must be admitted into the ventilation system. And before reducing ventilation, local code authorities should be consulted; but approval is generally granted on the basis that the system can be easily returned to original volume should the reduced air intake prove unsatisfactory.

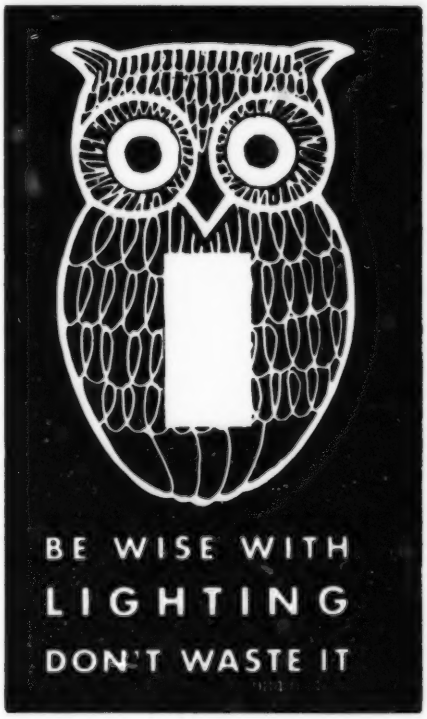
3M Canada's London office saved $16,000 per year, simply by installing timers on ventilation and air conditioning fans. Areas served by these fans were unoccupied during the night and on weekends, and seven-day timers were installed to control the required run time of the various fans.

Energy-wise lighting

There is a common misconception that leaving lights on saves more electricity than turning them off and on again. In the vast majority of cases, this is simply not true. There is a momentary surge of power when a light is turned on, but it is equal to only a millisecond or two of lighting time. "Turn off the lights" is one of the maxims of energy conservation. Train your employees to switch off lights, even when they are leaving for only a short time (15 minutes or more) and energy savings will result.

It's hard to measure just how much energy can be saved by having employees turn out lights for short periods of time. However, an experiment at one U.S. company shows definitively that turning out lights for short periods of time does save energy. The experiment involved a plant, not an office, but the principle is the same. This company decided to try turning out lights during a one hour lunch break. And, as in many cases, this company was concerned that the savings in electrical energy consumed by extinguishing the 1000 fluorescent light bulbs might be outstripped by costs incurred due to shorter lamp life. Turning off lights at lunch time saved the company $548 per year. Turning off lights, even for short periods of time, is an excellent — and profitable — habit to acquire.

Sticker fits over light switches



In Europe, some buildings have timers on light switches on stairways, for example, which keep the lights on for very short periods of time. As people walk up the stairs, they can turn on the

lights at each floor, but after about a minute, the light is automatically turned off. This idea shows just how extensively the idea of switching off lights for short periods of time can be used.

Help your employees achieve these savings by putting signs on light switches reminding them to turn lights off. Make sure light switches are highly visible. Consider the idea of changing panel switching for large work areas to wall switching for smaller areas — allowing employees to leave on only the lights that are required. Although it costs a few dollars extra for wiring and switching, energy savings will result.

Lights should also be turned out when the building is not in use. By turning off lights between 10:30 at night and 6:30 in the morning and on weekends at its main office, except in areas which require security lighting, Dominion Foundries and Steel Limited of Hamilton, Ontario saved 3 million Kwh / year or about $75,000 at current utility rates. Significant amounts of money can be saved in reduced fluorescent tubes alone. And turning off lights when buildings are not in use is a highly visible conservation measure. If both top management and employees are given realistic predictions of how much can be saved, this measure can be tapped as a valuable motivational tool.

And if you want to be with the trends, look into "task lighting" — it's definitely the wave of the future. In essence, it means lower overall lighting levels for the office, with smaller lamps directly on the work area to provide higher illumination only where required. It's a concept that will save money.

In the past, the general practice has been to light office buildings uniformly at 150 footcandles per square foot — or five watts per square foot. This level is not needed. Public Works Canada recommends 50 to 75 footcandles for task lighting and 30 to 50 footcandles for general lighting. Even if the highest recommended level — 75 footcandles — is used for the whole office, savings can be substantial. If the illumination level is reduced from 125-150 footcandles to 75-100 footcandles by removing tubes from fixtures, taking care not to leave unused ballasts energized, a saving of as much as 30% can result.

And savings can be even greater if levels are reduced even more in certain areas — cafeterias (when not in use), storage areas and elevators to name a few.

There are a few basic rules to follow when making changes to a lighting system:

- Provide an overall ambient level adequate for a majority of the tasks.
- Provide additional lighting where tasks require levels higher than the ambient level.
- Where the lighting system is modular, attempt to orient work stations to obtain highest contrast rendition in task lighting.
- The ambient lighting level must assure luminance levels for all surfaces in the field of view necessary for sight comfort i.e. luminance relationship between different areas in the field of view must be such that adaption required by the eyes as they change from a field of one brightness to another does not produce discomfort and fatigue.

One maxim which is being discarded is the idea that high light levels discourage burglars. Keeping the lights on all night wastes electricity and helps a potential thief to find quickly what he wants to steal. Premises can be more effectively protected by installing a sonic or electronic burglar alarm which consumes very little electricity. Another solution is to light aisles just enough to spot an intruder from the outside, if the area is patrolled.

12 IES Lighting Recommendations

1. Design lighting for expected activity (light for seeing tasks with less light in surrounding non-working areas).
2. Design with more effective luminaires and fenestration (use systems analysis based on life cycle).
3. Use of efficient light sources (higher tumen per watt output).
4. Use more efficient luminaires.
5. Use thermal controlled luminaires.
6. Use lighter finish on ceilings, walls, floor and furnishings.
7. Use efficient incandescent lamps.
8. Turn off lights when not needed.
9. Control window brightness.
10. Utilize daylighting as practicable.
11. Keep lighting equipment clean and in good working condition.
12. Post instructions covering operation and maintenance.

Dominion Foundries and Steel Limited had already reduced lighting substantially at its main office building by switching off all the lights at night and on weekends, except those required for security purposes. But the company decided to cut even this lighting to one quarter its former level per year to achieve further lighting savings.

Timers should be installed wherever possible to ensure that they are shut off at night, but there is really no substitute for employees who will flick off the switch when light is not needed. Aid them as much as possible. Make sure there are enough light switches so that lights *can* be switched off in unused areas.

Maximize daylight with fenestration and colour

Maximize daylight for illumination, and to complement electric illumination.

"Daylight is not free", according to lighting specialists, but that was truer yesterday than today. Improved reflective, double-glazed, low transmission and insulated glass has removed most of the heat loss disadvantage of earlier years. And, the excellent fenestration available today, plus the use of sun screening, shades, and blinds, aids in controlling incoming solar heat.

So utilize the daylight fenestration makes available. Reflect and deflect light further into the interior of the building with venetian blinds (can also be used to reduce glare) and light coloured surfaces.

Harness colour to save energy. Light, bright, highly reflective colours can increase illumination drastically. As one designer days, "You can't buy the extra 15 foot candles for what it costs to paint the ceiling." In one installation, repainting the ceiling, walls, and floor and refinishing the furniture boosted average illumination from below 10 foot candles to above 40. Capitalize on these IES recommended surface light reflectance values for schools and offices (top limits were chosen to minimize glare):

Ceiling finishes	*80 to 90 per cent*
Walls	*40 to 60 per cent*
Furniture	*25 to 45 per cent*
Office machines and equipment	*25 to 45 per cent*
Floors	*20 to 40 per cent*

As a final thought, light finishes or colours on ceilings, walls, floors and furnishings brighten a room because 90% of the light is reflected from the surface back into the room to reinforce the original light source. Similarly, high intensity decorative wall lighting consumes large amounts of energy and should be restricted in favour of other decorative techniques to produce aesthetically pleasing effects.

Using water efficiently

In most offices, hot and cold water account for only a very small percentage of energy consumed. However, this small amount of energy is important since appreciable savings can be made in areas where water is used — washrooms, kitchens and drinking fountains.

One simple way to cut down on energy is to make sure that water in washrooms is not being heated to too high a temperature. Water is normally heated to 60°C or 65°C, a temperature that is too hot to handle. By lowering the temperature to 50°C, savings of 15 to 20% can be achieved. In washrooms, the temperature can be set even lower — to 40°C which is the minimum required for washing hands.

Kitchens require hotter water, and money can be saved by boosting the water temperature locally, rather than heating storage tank water to the temperatures required. For example, if 82°C water is needed for commercial dishwashers, energy can be saved by reducing the storage tank temperature to 50°C and using a booster heater near the dishwasher to achieve the 32° increase. If the installation is sizable, consider installing a small heat exchanger to preheat incoming water by using the heat of the dishwater effluent.

Consider relocating the water heater so that it is as close to the point of use as possible. The longer the run, the more hot water sits in it cooling down between periods of hot water use.

Maintenance is also important. Inspect the water supply system and repair all leaks, including those at the faucets. Enlist your employees' support in reporting leaky faucets and have them repaired as soon as possible. One drop of water per second equals 650 gallons of water per year — a waste of 380 cubic feet of natural gas. (Unnecessarily hot water helps to wear out tap washers more quickly — causing leaks and

higher maintenance costs.)

Inspect and test hot water controls to determine if they are working properly. If not, either regulate, repair or replace them. Check insulation on storage tanks and piping, and repair or replace it as needed. Sometimes significant savings can be gained by increasing the amount of insulation installed on hot water pipes and storage tanks, or replacing the existing insulation with a type that has a better R factor.

There are many ways of limiting the use of water. Shut off domestic hot water circulating pumps during hours the building is not occupied, either manually or using a time clock. Many pumps operate automatically on a thermostat and run continually.

Methods of limiting hot water from taps include installation of spray type faucets with flow restrictors, and use of spring activated hot water taps.

Drinking fountains are often a waste of water and energy. Consider replacing free running drinking fountains with spigot types which use a paper cup. Up to half the water drawn by free-running fountains is wasted.

Standard Tube of Canada Limited found that refrigerated drinking fountains save money. Workers at its Woodstock, Ontario plant would wedge faucet handles in the "on" position to ensure cold drinking water by continuous water flow. As a remedy, the company installed 17 refrigerated coolers providing a substantial water use saving offset slightly by the cost of refrigeration. The company expects to save $1,700 per year.

Sangamo Limited in Toronto found a unique way to save water in its washrooms. By means of a simple adjustment to urinal dump valves in men's washrooms, flush cycles were cut from 42 per hour to 20 per hour with no effect on sanitary conditions. The estimated savings are $1,800 for the first year. The cost . . . nothing.

Changing routines to save energy

Heating, cooling, ventilation, water and lighting are not the only areas in which office energy savings can be achieved. Frequently, changes in office routine can be effective in saving energy. Consider the amount of lighting and heating required for the average office, and how much of this energy could be saved if the length of time required for heating and lighting the building were cut down.

This can be done in several ways. One Canadian company has cut working hours from 8:30 to 5:00 to 8:30 to 4:30 by reducing the lunch hour from one hour to half an hour. Most of the employees were very pleased with the change. And reduction of office hours meant a reduction in heating and lighting costs.

On the other hand, many companies encourage flexible working hours so that employees are not caught in rush hour traffic on the way to work. This system uses more heating and lighting in the office, but fuel is saved outside the office.

Working on the principle that reduction of working hours saves energy, Detroit Diesel decided to have janitorial services performed during the day shift so that lights could be turned off at the end of the shift. Previously, the service began at the end of the day shift, requiring office lights to be left on until 2 a.m., needlessly consuming energy. The energy saved amounted to 2,500 MMBtu/year at a value of $5,000 per year. In some cases, it is not practical to have janitorial and service functions carried out during office hours, but even if only some are scheduled earlier, the energy and dollar savings can be substantial.

In cases where the janitorial staff must clean the offices after hours, energy could be conserved if employees were instructed to turn off the lights when they have completed their job and the janitors were told to turn off the lights when they have completed their job. In some instances it is standard practice for the lights to be left on until the janitorial service is finished — often until the early hours of the morning.

Using office machines less

Photocopiers, electric typewriters, adding machines, coffee pots, vending machines and water coolers are some of the machines found in offices that use up energy. Substantial savings can be gained by shutting these machines off when not in use. For instance, one company with 11 water coolers and 8 vending machines saved almost $200 a year by shutting these machines off at night.

Take an inventory and decide whether you really

need some of the frills — wouldn't manual pencil sharpeners do just as well as electric ones? Do you really need an electric-powered stapler?

Check and see whether people are using individual electric soup pots or kettles to boil water for coffee. Discourage these. It is much more economical in terms of energy to have a central coffee depot with a coffee pot and a kettle, or to use central vending machines.

Elevators can be great energy wasters. Encourage employees to take the stairs for short trips — to walk one floor going up and two floors going down is the rule used by people in the federal government.

Other ways of cutting down on elevator use include reduction of use after office hours — closing down one elevator completely, for example. Some companies have installed demand devices whereby the elevators will answer calls only if a certain number of people need the service. And, if the office is large enough, elevators can be fixed so that they go only to certain floors.

The paper jungle

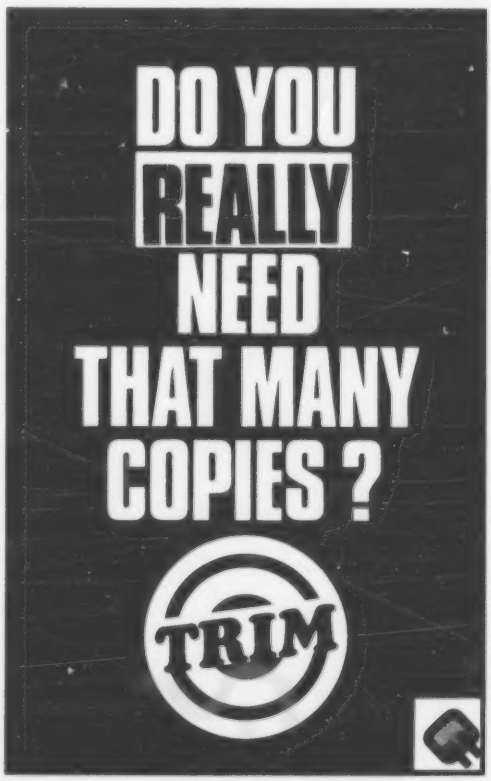
Whether your company produces tires, furniture, or steel, one of its main "products" is paper — files, memos, photocopies, books, reports, invoices and letters. Paper is not normally associated with energy consumption. But think of all the energy required to make the paper and to ship it; the human energy needed to process it, read it and file it; the energy required to build the filing cabinets to store it; and the money and energy required to build storage space to house the filing cabinets. Paper is an energy user. And the sad part is that much of the paper used in offices today is unnecessary.

The statistics become more real when quantified. For purposes of its paper trimming program, Ontario Hydro studied the situation, and although its figures are approximate, they give some idea of just how much paper a large corporation can use. Ontario Hydro spent $900,000 purchasing some 60 million sheets of paper during 1975 — or about 3,000 sheets per employee. One thousand sheets per person were created through photocopying. Over 9,000 mature trees had to be cut down to supply paper for Ontario Hydro that year.

The company also has 150 to 200 million pages of records. Even if one-third of these are ignored as being made up of books, manuals, catalogues and other necessary publications, the rest of the documents add up to a pile of paper nearly 39 times the height of the CN tower. The company is actively working to eliminate as much of this wastage as possible.

There are many ways to get rid of excess paper, but the most important thing to remember is to let employees know why you are trying to trim the paper load. Let them throw their own paper away; otherwise they will feel threatened.

Ontario Hydro sign for photocopiers



Try some of the following suggestions:

- Route memos rather than making copies for everyone. This will cut down on use of the photocopier as well as use of paper. The same principle applies to magazine articles and newspapers — route them rather than photocopying.
- Get people to look through their files and throw out any that are out-of-date or unnecessary. Studies show that companies never refer to

85% of their records while 95% of all references are to records under three years of age; and that 45% of filing equipment space is tied up in storing duplicate copies of dubious value. Fewer files mean less storage space and fewer filing cabinets.

- Recycle paper. Use scrap paper for rough drafts of letters, etc. What does it matter that the paper has been printed on one side? The federal Department of Energy, Mines and Resources has cut down on paper use by printing reports on the back of outdated maps.
- Reduce the number of photocopies made by having the person whose desk is closest to the photocopy machine keep tabs on its use; providing a key to restricted personnel to operate it; logging the number of copies; or using machine counters to keep track of copies.
- Photocopy and print on both sides of paper.
- Use alternatives to photocopying. If up to five copies are required, carbon copies are less expensive and ditto masters are recommended for more than five. However, it is not always easy to convince people of the merits of these two methods over the photocopier. In fact, factors such as difficulty of correcting errors on multiple copies can make use of carbon paper less productive, and depending on typing skill, a penalty due to high spoilage rates can result. However, for one or two copies it is always more economical to use carbons over photocopies.
- Sometimes it costs less to take chances rather than keeping records of costs down to the last penny. Marks and Spencer had a central inventory which listed the company's supplies in minute detail, down to the number of electric light bulbs at each store. But the company found that the cost of losses was less than the expense of this detailed control, and the inventory was abandoned. Take a look at your inventory system and decide whether the cost of perfection is too high.
- One branch of the same store further boosted morale by suggesting a saving on time clock cards. It abolished the clocks. Several stores followed suit, and after some weeks reported that punctuality had actually improved. Employees liked being trusted. And the company saved a million time cards per year.
- Use the phone rather than writing. Considering the cost of the average business letter, how many can be eliminated with a telephone call?
- Keep forms short and to the point. Not only will you save paper, but you'll save the time spent on filling out long, complex forms.
- Look into the micrographics field in which 280 pages, 15" by 11", can be reduced onto 14" by 6" fiche. Unless the document is legal and must be retained, its information on fiche is perfectly adequate, as well as easy to retrieve, cheap to produce, and cheap to store.
- Be careful with word processing equipment. While it can indeed produce letters, etc. at a lower unit price, it can also simply provide an excuse to produce more paper if it is not combined with a systematic review of paperwork.

Paper trimming programs may not look like big money or energy savers if you look at each sheet of paper individually, but the savings add up when the program is used by everyone in the office. And as well as providing money and energy savings, less paper usually means a more efficient office with time saved through less typing, reading and filing.

Purchasing with conservation in mind

The same principle that applies to paper also applies to office furniture and appliances. It takes energy to manufacture all these items, and every time something is thrown out, energy is wasted. When purchasing, keep this in mind. Buy products that are built to last. If old furniture is past its prime, consider refinishing or recovering it rather than throwing it out. It takes much less energy to refinish a desk than it does to build a new one. Take the old articles to second hand shops, or to the Salvation Army so that someone else can use them.

Companies can achieve savings by instituting a surplus equipment and furniture program — using in-house older pieces of furniture and equipment, thereby avoiding new purchases. For example, second hand office furniture can be used in plant areas where equipment is subject to abuse. Old typewriters can often prove useful in areas where the typing required is low in

volume. The amount of time required to co-ordinate such a program is small in comparison to the return realized.

When purchasing office equipment, keep energy in mind. Some photocopiers use less energy than others, for instance. If a requisition is received for an item that seems to constitute a waste of energy — be it an extra filing cabinet that will just house more paper, another electric typewriter or an air conditioning unit — make sure the extra energy use can be justified.

In short, be energy conscious about what you buy. The purchasing department is one place to stop growth of energy demand in the office.

The savings add up

Offices offer many energy-saving opportunities, and while many of the areas for saving may seem insignificant in themselves, they will add up to impressive energy savings.

In addition, many of the changes have beneficial side effects. Cutting down on paperwork can ease the burden on office employees and eliminate many routine and boring functions. Caulking windows may get rid of irritating drafts. Cutting down working hours to save on heating and lighting is a popular measure with many employees. And the doctors tell us that 20°C is a healthy temperature, and that using stairs instead of elevators is good for us.

Try some of the measures outlined in this booklet. If one company can save $1,700 per year by installing refrigerated drinking fountains, and another can save $5,000 a year by having the janitors clean during office hours — your company can make real savings too — without a major capital investment.

Tips on saving energy and money in office practices

Heating

1. Turn down the thermostat to 20°C during the day and 17°C during the night and on weekends.
2. Install a dual thermostat/timer system to activate a "night thermostat" on evenings and weekends.
3. Discourage use of space heaters by employees.
4. Encourage more casual, but warmer clothing.
5. Make sure the thermostats are located away from drafts or sources of heat.
6. Close drapes at night for extra insulation.
7. Install drapes lined with foil for insulation in winter.
8. When the winter sun is shining, open drapes and let solar heat supplement the heating system.
9. Make sure nothing is blocking sources of heat.
10. Consider removal of partitions to enable air to circulate freely in cases where they are keeping heat from some areas of the office.
11. If only some parts of the office are to be heated, use barriers to block off unheated areas.
12. Keep doors to unheated rooms and storage areas closed.
13. Consider installing zone controls if some areas of the office don't have to be heated.
14. Caulk windows and weatherstrip doors to keep the heat in.
15. Make sure the heating system is in good shape.

Cooling

16. Avoid use of air conditioning if possible.
17. Use fans since they require less energy.
18. Encourage employees to wear light clothing in summer.
19. Don't use appliances (photocopiers, electric typewriters) in summer unless you have to — they generate heat.
20. Turn out lights since they also generate heat.
21. Keep doors and windows closed during the hot part of the day if it's cooler inside, but open windows if there is a breeze.
22. Keep drapes closed during the day.
23. Use light drapes and blinds, awnings, sun screens, panels, overhangs or reflecting

windows to reduce solar heat.

24. If air conditioning is needed, make sure the unit is the right size for the office, i.e. the least amount of energy for the required amount of cooling. Check the Energy Efficiency Rating (EER).
25. Set air conditioners as high as possible without creating discomfort — 26 to 27°C.
26. Turn off the air conditioner and open windows during cool periods to save energy, but tell employees to keep windows closed when the air conditioner is on.
27. Make sure the air conditioner is well maintained.
28. Consider conversion to a "variable-air-volume" system, after obtaining advice from a consultant.

Ventilation

29. Check to see whether ventilation can be reduced, but consult local code authorities for approvals.
30. Install timers on ventilation fans.

Lighting

31. Turn off the lights, even when leaving for only a short time.
32. Install timers on lighting fixtures to shut them off on evenings and weekends.
33. Put signs on light switches reminding employees to turn them off.
34. Make sure light switches are highly visible.
35. Consider changing panel switching for large work areas to wall switching for smaller areas.
36. Look into "task" lighting.
37. Reduce security lighting on nights and weekends.
38. Use light finishes or colours on ceilings, walls, floors and furnishings to reflect light and reinforce the original light source.

Water

39. Heat water in washrooms only to 100°F, the minimum required for washing hands.
40. Boost the water temperature locally to provide hotter water for kitchens.
41. Consider installing a small heat exchanger in kitchens to preheat incoming water by using the heat of the dish water effluent.
42. Consider relocating water heaters so that they are as close to the point of use as possible.
43. Maintain the water supply system and repair leaks as soon as possible.
44. Regulate, repair or replace hot water controls that are not working properly.
45. Repair, replace or upgrade insulation on storage tanks if necessary.
46. Shut off domestic hot water circulating pumps during hours when the building is not occupied.
47. Install spray type faucets with flow restrictors or use spring activated hot water taps to control water use.
48. Consider replacement of free-running drinking fountains with spigot types that use a cup.
49. Use refrigerated drinking fountains to stop employees from wedging free-running drinking fountain handles in the "on" position to ensure cold water.
50. Cut down the number of flush cycles per hour on urinals.

Changing routines

51. Cut down the length of time required for lighting and heating by shortening office hours, e.g. changing hours from 8:30 to 5:00 to 8:30 to 4:30 by reducing the lunch hour from one hour to half an hour.
52. Encourage flexible working hours so that employees are not caught in rush hour traffic, and save gasoline travelling to and from the office.
53. Perform janitorial services during office hours, or schedule them earlier to save on heating and lighting.

Using office machines less

54. Shut off electric typewriters, photocopiers, adding machines, coffee pots, vending machines, water coolers etc. when not in use.

55. Don't purchase energy-hungry "frills" such as electric pencil sharpeners and staplers.
56. Discourage use of individual electric soup pots or kettles. Set up a central coffee depot or vending machine area instead.
57. Encourage use of stairs instead of elevators.
58. Reduce use of elevators after office hours.
59. Install demand devices whereby elevators answer calls only if a certain number of people need the service.
60. Fix elevators so that they go only to certain floors.

The paper jungle

61. Tell employees why you want to cut down on the amount of paper used, and let them throw their own paper away.
62. Route memos, magazines and newspapers rather than photocopying.
63. Throw out files that are out-of-date or unnecessary.
64. Use scrap paper for rough drafts of letters, etc.
65. Keep tabs on the photocopy machine.
66. Photocopy and print on both sides of paper.
67. Consider use of carbon copies and ditto masters as alternatives to photocopying.
68. Take a look at your inventory system and decide whether it is really saving you money.
69. Abolish time clock cards to save on paper and improve morale.
70. Use the phone rather than writing.
71. Keep forms short and to the point.
72. Look into micrographics for document storage.
73. Make sure that word processing equipment is not simply an excuse to produce more paper.

Purchasing

74. Buy products that are built to last.
75. Consider refinishing or recovering old furniture rather than throwing it out.
76. Take old articles to second hand shops or the Salvation Army; or use them in-house in areas where furniture is subject to abuse (e.g. plant areas).
77. Use old typewriters in areas where typing required is low in volume.
78. Keep energy conservation in mind when purchasing items such as photocopiers — some types consume more energy than others.
79. Question purchase requisitions for items that seem to constitute a waste of energy.

Conversion of office lighting saves 50% of energy

The situation: The Norquay Building in Winnipeg, a 10-story office block with 130,000 square feet of floor area, had a 14-year-old lighting system that had discoloured badly and provided poor, reduced lighting. Existing 15-square foot modules used two 40 watt RS fluorescent lamps and a PVC diffuser. Consumption in each module was 6.6 watts per square foot, giving a raw footcandle reading of 110.

Action taken: On a trial basis, a contractor installed a special vaulted ceiling with acoustic tile and one 40-watt RS fluorescent lamp per vault with a special injection moulded plexiglass lens. Consumption per module was only 3.6 watts per square foot with illumination reading increased to 120 footcandles. This design was subsequently modified for the rest of the building by using a slightly different acoustical vaulted ceiling and one 30-watt RS lamp per module with the same plexiglass lens. Consumption per module was 3 watts per square foot, giving a footcandle reading of 110.

Energy/dollar savings: Energy consumption and costs were cut in half right from the start since the new lighting system used only one fluorescent tube per ceiling vault instead of two.

Dollar savings: With energy prices at 1.5¢/Kwh and maintenance at 10¢/lamp/month, a cost appraisal reveals a saving of $30,000 per year for the entire building—enough to pay for the complete upgrading over a ten-year span. In addition, there were added benefits of improved visual environment, reduced glare and better acoustics.

Recommendation: If your lighting system is inefficient or antiquated, take a look at ways of improving it. The Norquay Building improvements were relatively expensive since changes were made to the ceiling as well as the lighting, but often changing the lenses in fluorescent fixtures can make a difference and may allow you to use fewer tubes.

Janitorial service performed during office hours

The situation: At a Detroit Diesel plant, janitorial service was scheduled to begin after the end of the office day shift — requiring office lights to be left on until 2 a.m. needlessly consuming energy.

Action taken:
Janitorial services are now performed during the office day shift so that lights can now be turned off at the end of the shift (from 5:30 p.m. until 6:30 a.m.)

Energy savings:

Previous consumption:

$$4200 \text{ kw} \times \frac{5375 \text{ hrs}}{\text{yr}} \times \frac{3413 \times 10^{-6} \text{ MMBtu}}{\text{Kwh}} = 77.000 \frac{\text{MMBtu}}{\text{yr}}$$

Present consumption:

$$4200 \text{ kw} \times \frac{4440 \text{ hrs}}{\text{yr}} \times \frac{3413 \times 10^{-6} \text{ MMBtu}}{\text{Kwh}} = 63.600 \frac{\text{MMBtu}}{\text{yr}}$$

Savings: $77{,}000 - 63{,}600 = 13{,}400 \frac{\text{MMBtu}}{\text{yr}}$

Cost of improvement: Nil.

Recommendation: Some, if not all, janitorial and other service functions presently carried out off shift should be carried out during a regular shift period. Benefits in terms of energy, and dollar, savings can be substantial.

Reduced ventilation reduces office heating load

The situation: An office in the northern part of the United States with 8,000 degree days, has an occupancy of 667 people and was supplied with 30 cfm/person of outside ventilation air for 40 hr/wk during the heating season. A consultant determined that this rate of ventilation could be reduced substantially in order to conserve energy in heating the building.

Action taken: Inflow of outside air was reduced of 8 cfm/person resulting in an overall ventilation rate reduction of (30-8) cfm/persons $\times$ 667 persons = 14,700 cfm.

Energy savings: Given an 8,000 degree days level, each 1,000 cfm of ventilation provided for 40 hr/wk requires 52.4 MMBtu heating energy per season (from table)

$$\text{Savings} = \frac{52.4\ \text{MMBtu}}{1000\ \text{cfm}} \times 14{,}700\ \text{cfm} = 770\ \text{MMBtu}$$

Dollar savings: 770 MMBtu/yr = 770 Mcf @ $2.00 = $1,540/year.

Cost of improvement: Nil.

Recommendation: Have a knowledgeable colleague or consultant determine present ventilation air rates, either from ventilating fan ratings or by measuring with an anemometer. These can then be checked against minimum required rates as established by codes for your business. Reductions in ventilation rates — and savings in energy are frequently possible.

Reduction in flush cycles conserves water

The situation: The energy conservation committee at Sangamo Limited's Toronto plant were as concerned with water savings as saving "energy". As a result, they saw the potential for significant savings in washroom water consumption, at no cost.

Action taken: By means of a simple adjustment to urinal dump valves in plant washrooms, flush cycles were cut from 42/hr to 20/hr with no effect on sanitary conditions.

Water/dollar savings: Estimated water savings during the first year of operation amounted to $1,800.

Cost of improvement: Nil.

Recommendation: No energy conservation program is too small. Reductions in water consumption in office and plant washrooms can be achieved by a number of means, including manual flushing for facilities and use of spring loaded faucets. These measures are low-cost and offer a high return on investment and a high "visibility" to employees.

Refrigerated water fountains save water

The situation: At the Woodstock, Ontario plant at Standard Tube of Canada Limited, 17 unrefrigerated water fountains represented a major waste of water resources. Workers in the plant wedged faucet handles in the "on" position to assure cold drinking water by continuous water flow. The fountains used a total of 780 gallons per hour and incurred a water cost of $1,800 per year.

Action taken: To obviate the need for continuously running water, the company installed 17 refrigerated coolers providing a very substantial water use saving — with a small offsetting cost for energy consumed in refrigeration.

Energy/dollar saving: No energy saving. A water savings equal to $1,700 per year is expected.

Cost of improvement: 17 coolers @ $350 = $5,950.

Recommendation: Give consideration to refrigerated water coolers as a means of saving water and at the same time improving employee morale and commitment to energy conservation. To make sure employees know that the coolers are actually saving money (and not just consuming greater amounts of energy), a small sign on the wall over the fountain might be appropriate.

Turning off lights at night and on weekends

The situation: Dominion Foundries and Steel (DOFASCO) has a 5 storey, 160,000 sq. ft. main office building located adjacent to its plant in Hamilton, Ontario.

Action taken: For a number of years, it has been the procedure to reduce lighting to about 5% between 10:30 p.m. and 6:30 a.m. and on weekends. The lights left on were for security. Recently, the company has also decided to reduce the security lighting and has wired out 3 of the 4 switches.

Energy savings: total savings due to turning out lights in off periods are about 3,000,000 Kwh per year.

Dollar savings: 3,000,000 Kwh/year × 2.5¢/Kwh = $75,000.

Recommendations: Reduction of lighting at night and on weekends, except for a few lights left on for security purposes can produce significant energy savings.

Window tinting cuts solar radiation gain

The situation: At the Hartford, Connecticut, head office building of the Phoenix Mutual Life Insurance Company, temperatures would reach 80—85°F on hot days because of its all-glass construction. With 1,050 people occupying 290,000 square feet of usable space, it was necessary to maintain more comfortable interior temperatures. Additional air-conditioning would have been "enormously expensive".

Action taken: Phoenix Mutual chose to apply a reflective sun-control film to the interior of all windows with southern and western exposure (a total of 22,700 sq. ft. of glass). The film chosen was a medium grade of silver-gray reflective film that transmits 33% of the sun's light.

Energy saved: It is estimated that the reflective film will reduce chilled water consumption for cooling by six percent or 5,000 tons per year.

Dollar savings: Not available.

Recommendation: Look toward reflective coatings as an alternative to installation of additional expensive air-conditioning.

SI USAGE

Derived SI Units Having Special Names

Quantity	Unit	Formula	Symbol
Frequency	hertz	s^{-1}	Hz
Force	newton	$kg \cdot m/s^2$	N
Pressure or Stress	pascal	N/m^2	Pa
Energy or Work	joule	$N \cdot m$	J
Power	watt	J/s	W
Electric charge	coulomb	$A \cdot s$	C
Electric potential	volt	W/A	V
Electric resistance	ohm	V/A	Ω
Electric conductance	siemens	A/V	S
Electric capacitance	farad	C/V	F
Magnetic flux	weber	$V \cdot s$	Wb
Magnetic flux density	tesla	Wb/m^2	T
Inductance	henry	Wb/A	H
Luminous flux	lumen	$cd \cdot sr$	lm
Illuminance	lux	lm/m^2	lx

Common Equivalents and Conversions

Approximate Common Equivalents
1 in. = 25 mm
1 ft. = 0.30 m
1 yard = 0.91 m
1 mile = 1.6 km
1 sq. in. = 6.5 cm^2
1 sq. ft. = 0.09 m^2
1 sq. yd. = 0.84 m^2
1 acre = 0.40 ha
1 cu. in. = 16 cm^3
1 cu. ft. = 28 dm^3
1 cu. yd. = 0.76 m^3
1 quart (liq) = 1.1 ℓ
1 gallon = 4.5 ℓ
1 oz. (Avdp.) = 28 g
1 lb. (Avdp.) = 0.45 kg
1 hp (UK) = 0.746 kW
1 lbf. = 4.4 N
1 psi = 6.9 kPa

Some Other Derived SI Units

Quantity	Unit	Symbol
Area	square metre	m^2
Volume	cubic metre	m^3
Velocity-angular	radian per second	rad/s
Velocity-linear	metre per second	m/s
Acceleration-angular	radian per second squared	rad/s^2
Acceleration-linear	metre per second squared	m/s^2
Density (mass per unit volume)	kilogram per cubic metre	kg/m^3
Moment of force	newton metre	$N \cdot m$
Viscosity-dynamic	pascal second	$Pa \cdot s$
Thermal conductivity	watt per metre kelvin	$W/(m \cdot K)$
Thermal flux density, Irradiance	watt per square metre	W/m^2
Thermal capacity or Entropy	joule per kelvin	J/K
Permeability	henry per metre	H/m
Permittivity	farad per metre	F/m
Thermal resistance (R value)	square metre kelvin per watt	m^2K/w
Energy density	joule per cubic metre	J/m^3

SI PREFIXES

Multiplying Factor	Prefix	Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deca	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

Some Non-SI Units Used with the SI

Unit	Symbol	Value in SI Units
minute	min	1 min = 60 s
hour	h	1 h = 3600 s
day	d	1 d = 86 400 s
degree (of arc)	°	$1^{\circ} = (\pi/180)$ rad
minute (of arc)	'	$1' = (\pi/10\,800)$ rad
second (of arc)	"	$1'' = (\pi/648\,000)$ rad
litre	l or ℓ	1 ℓ = 1 dm^3 = 10^{-3} m^3
tonne	t	1 t = 10^3 kg = 1000 kg
hectare	ha	1 ha = 10 000 m^2

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